

Solar Cookers Effective Tools for 3-D Learning

Presented at the National Science Teachers Association (NSTA) Conference in Atlanta, Georgia

March 17, 2018

by

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&

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PART 1

Global Development Solutions



Our mission is to connect
and support
those working at the grass-roots level
to solve quality of life issues
in ways consistent
with the principles and goals of GDS.

Do good well.
GDSnonprofit.org

Mary Buchenic

The Solar Sisters Project GDSnonprofit

**Working to promote
solar cookers
as tools for education,
wellness,
economic empowerment,
and ecosystem recovery.**

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Visit

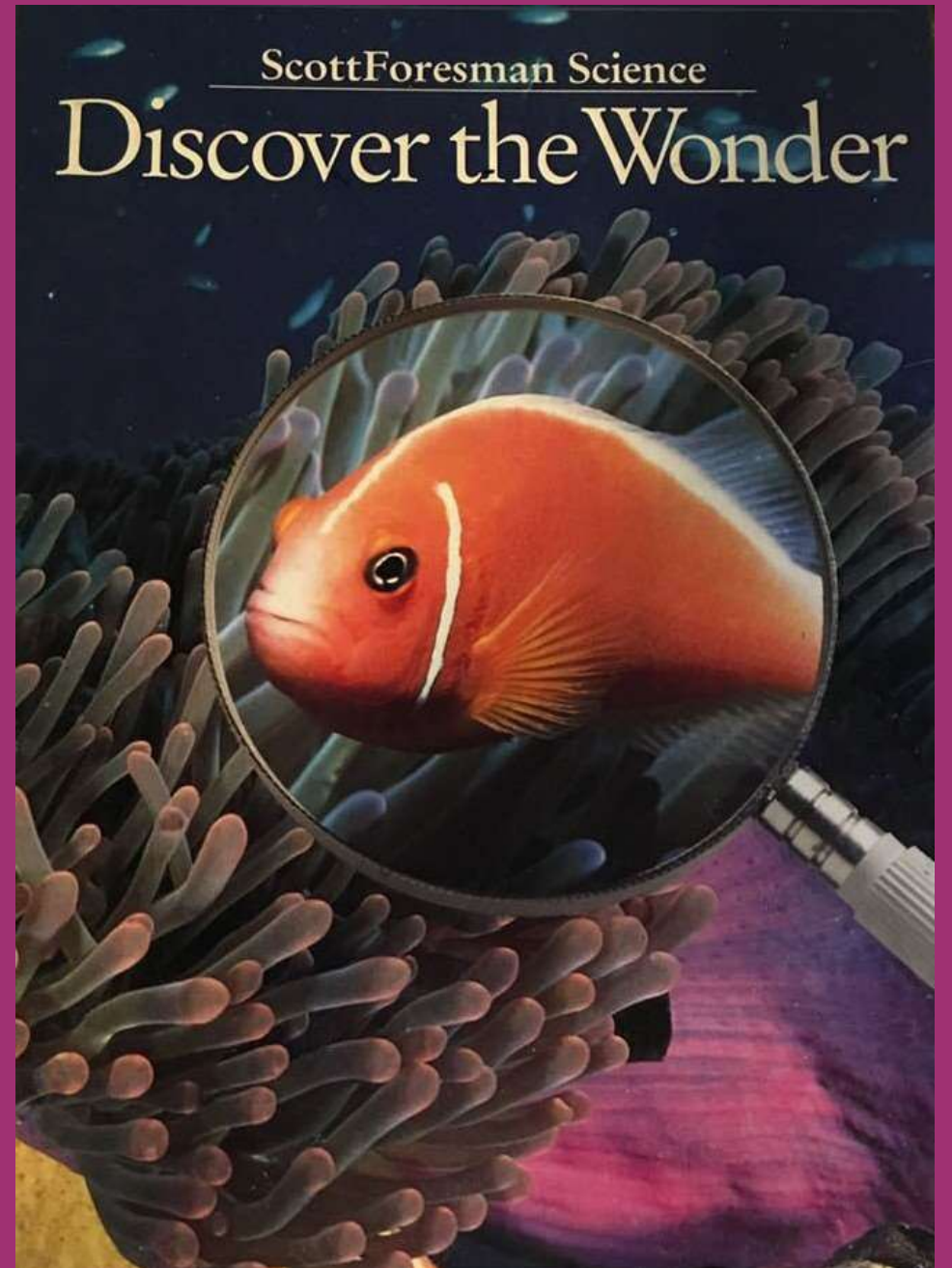
gdsnonprofit.org/solar-cooker-education
for session slides, solar cooking lessons,
experiments, & patterns,
and to learn about our mission work.



Mission
To spread solar thermal
cooking technology to
benefit people and
environments.

solarcookers.org
Visit solarcooking.wikia.com
for great educational
information on the solar
cooking movement

How I Discovered the Wonder of Solar Cooking in 1996



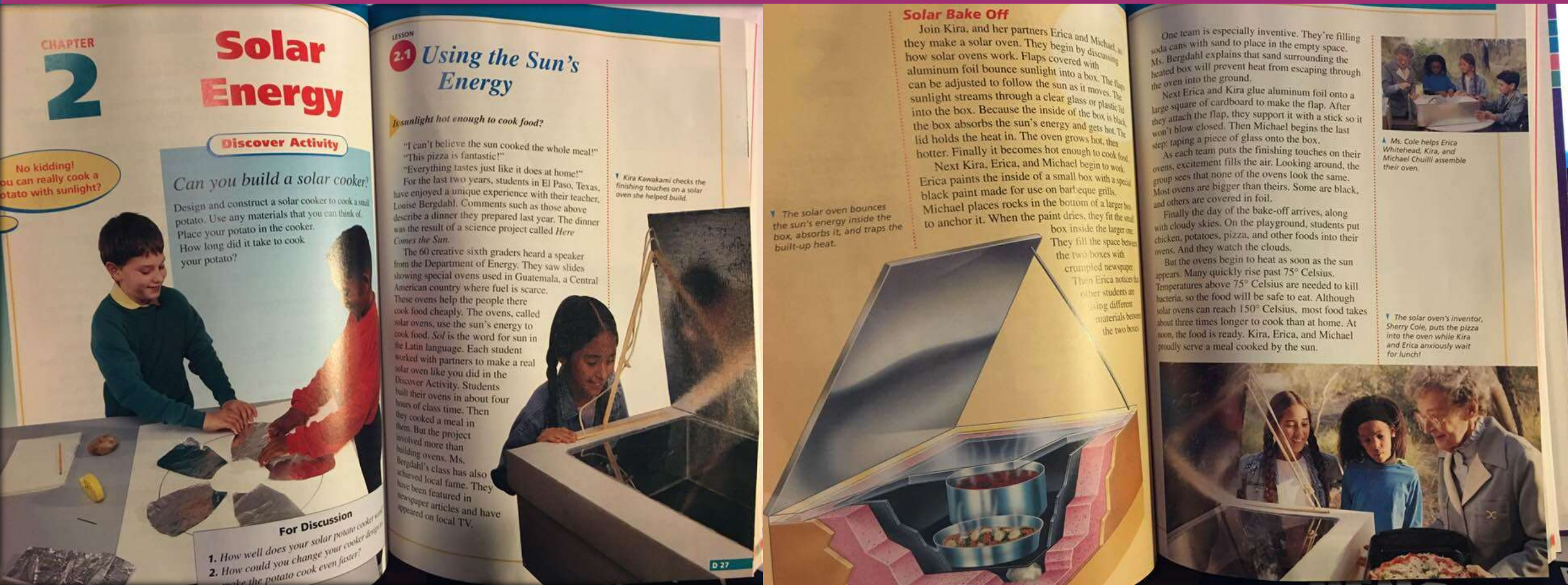
FOUR PAGES of a new Science Textbook!

1

2

3

4



15 YEARS

*100 students
per year =
1,500 students*

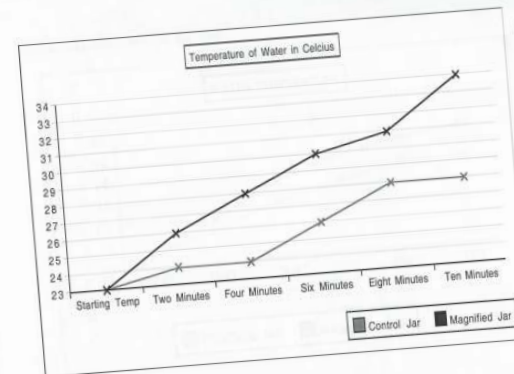
RESEARCHED

DESIGNED

BUILT

TESTED

*their own
unique solar
ovens.*



Many differentiated learning opportunities.

There's food involved.

Motivates.

Concepts transfer more readily.

Reinforces understanding of core ideas.

Eliminates discipline issues.

Students experience how knowledge and skills can be applied.

Promotes deeper understanding of content.

Provides opportunity for intercultural understanding.

What I loved about using Solar Cooking as the theme for 3-Dimensional and Cross Curricular learning.

Develops better relationships with co-workers.

Topic lends itself to several disciplines.

Students see tangible results of their planning, designing and constructing.

Students understand how technology can benefit people.

Work cooperatively with co-workers in a supportive manner.

Students witness teachers cooperating and can use this example for their own work ethic.

Challenges creativity.

Students understand the benefit of collaboration.

Students recall the experience years later.

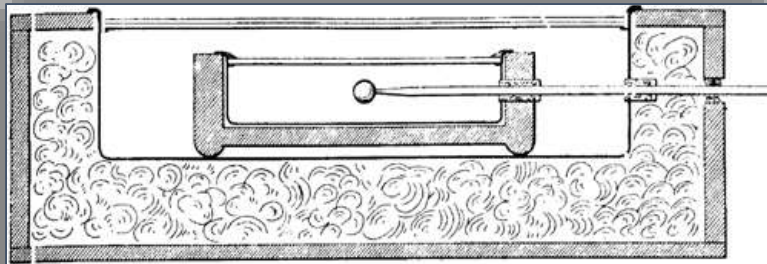
Opportunity to develop altruism.

Multiple applications.

Gives rise to authentic purpose for learning.

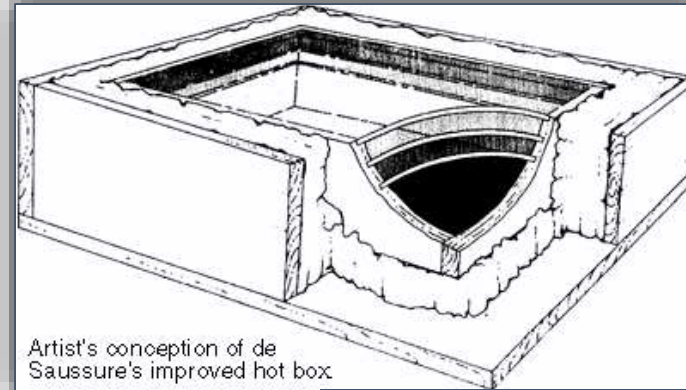
Basic Introduction to Solar Cooking

Sample of Early Solar Ovens



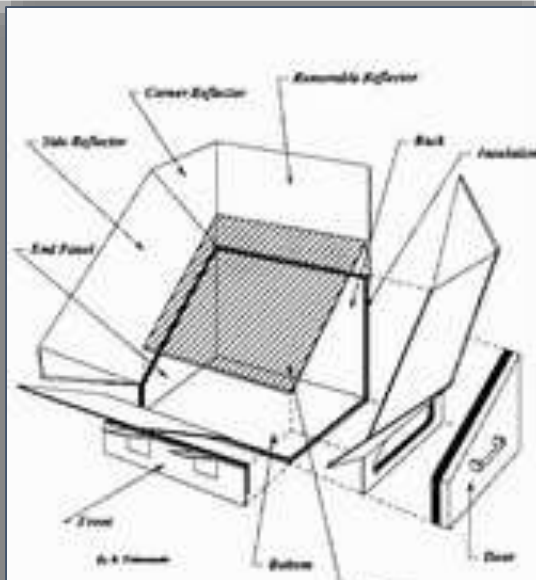
Cross-section of Langley's hot box, which was similar to de Saussure's later models. A thermometer penetrating the walls at right was used to measure the air temperature inside the inner box.

Samuel Langley 1884



Artist's conception of de Saussure's improved hot box.

Horace de Saussure's hot box - 1767



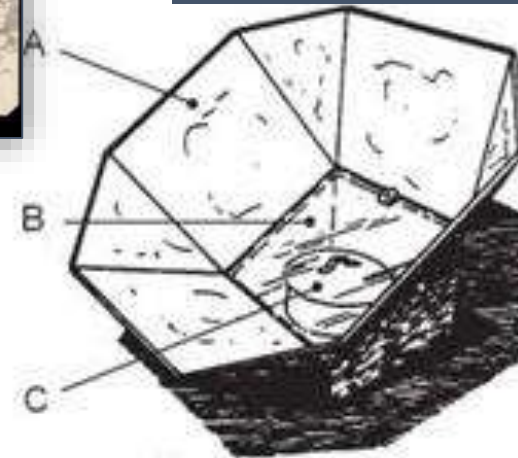
Design of 1950's box oven by Maria Telkes, physical chemist & biophysicist.
Source: Arizona State University



SolarCooking.org

EnergyProfessionalSymposium.com

W Adams 1878 Bombay, India
Eight mirrors reflect light into wooden box.



Transform sunlight to heat energy. Retain it for cooking.

SUNLIGHT IS YOUR FUEL

Direct extra sunlight

One or more shiny surfaces reflect extra sunlight onto the cooking pan, increasing its heat potential.

Absorb light and convert to heat

Dark surfaces get very hot in sunlight, whereas light surfaces don't. Food cooks best in dark, shallow, thin metal pots with dark, tight-fitting lids to hold in heat and moisture.

Retain heat

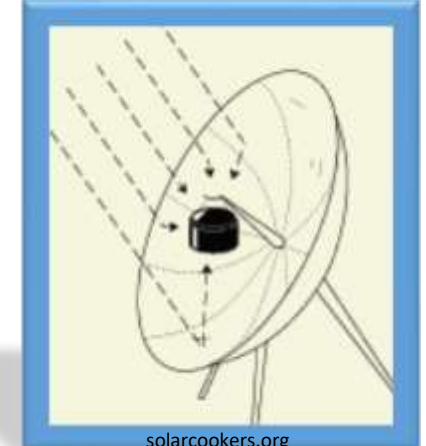
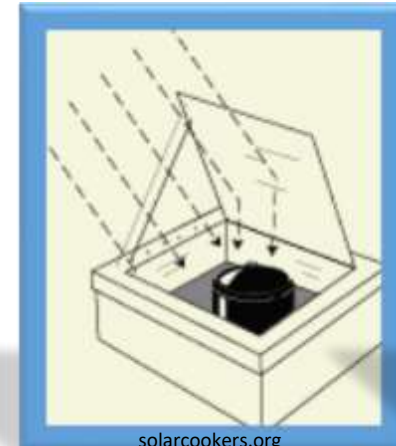
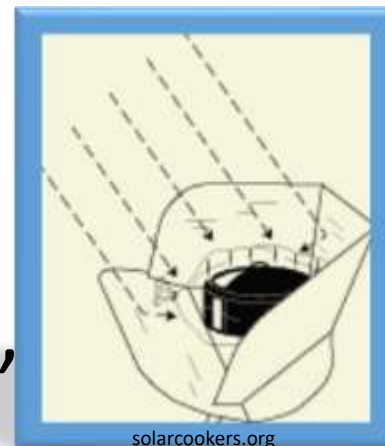
A transparent heat trap around the dark pot lets in sunlight, but won't let the heat out. For panel ovens, use a clear oven bag or inverted glass bowls. For box oven, use insulation and a transparent window.

Eat and enjoy your solar cooked food.

Eat and enjoy healthy and nutritious food cooked with the cleanest burning fuel there is.

“DARE to cook with sunshine!”

TheSolarSisters, GDSnonprofit.org



BOX OVEN

- Box ovens use reflectors to direct sunlight into the cooking space.
- The oven interior includes one or more black walls.
- The oven is well insulated to retain heat.
- Box ovens can reach temperatures of 325° F in a direct sun.

BOX OVEN

Gluten Free Lemon Cake

John Buchenic, USA



PANEL OVEN

- Uses reflective material to direct sunlight into a cooking space.
- Cooking space holds a black cooking pan that absorbs sunlight and converts it to heat.
- Heat is retained by using a transparent enclosure such as an oven bag or inverted pyrex bowls.
- Approximate Range: 200° F – 325° F

PANEL OVEN

Steamed Rice

Wade Steene, USA



PANEL OVEN

Baked Pork Chop

Mary Buchenic, USA



EVACUATED TUBE

- Double layers of glass with no air in between.
- Food is placed inside the tube.
- The dark interior part of the tube absorbs the light and converts it to heat.
- The evacuated space between the glass layers prevents heat loss.
- Approximate range 250° F – 400° F

EVACUATED TUBE

Chicken

Mary Buchenic, USA



EVACUATED TUBE

Bread
Mary Buchenic, USA



PARABOLIC OVEN

- Concentrates many rays of light onto a black cooking pan.
- The amount of concentrated light can result in heating the food similar to placing it on a burner.
- Deep parabolics spread the concentrated light around the cooking pan.
- Shallow parabolics focus light more tightly.

PARABOLIC

Frying Food

Janos Baglyios,
Hungary



PARABOLIC

Popcorn

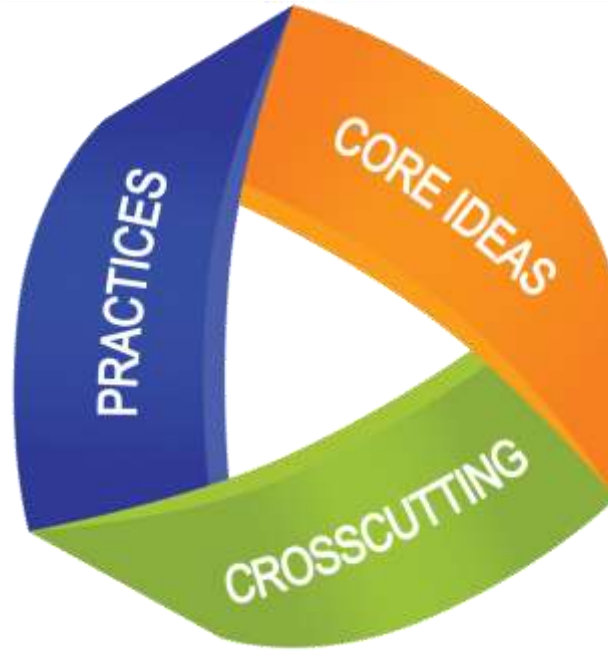
John Buchenic, USA



SAFETY

- Do not look directly at the sun.
- Do not look into the glare of the reflectors.
- Use oven mitts to handle hot pots and pans.
- Use a thermometer to test for safe internal temperature of meats.
- Keep hands and food preparation areas clean.
- Be aware of allergies when preparing food.
- Solar cooking requires sunshine. Do not attempt to cook on a cloudy day.

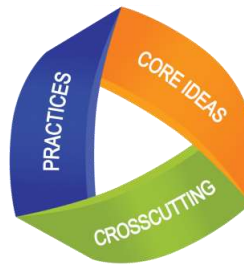
Solar Cookers are 3-Dimensional!



The Next Generation Science Standards were released in 2013.

“Lessons and units aligned to the standards should be three-dimensional; that is, they should allow students to actively engage with the practices and apply the crosscutting concepts to deepen their understanding of core ideas across science disciplines.” *nextgenscience.org*

Solar Cooker themed lessons align easily with the concept of three dimensional learning.



Dimension 1

DISCIPLINARY CORE IDEAS

Key ideas in science that build on each other

GROUPED BY FOUR DOMAINS

Physical Science

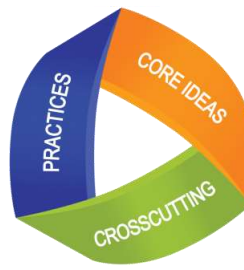
Life Science

Earth and Space Science

Engineering, Technology & Application

nextgenscience.org

Rank the domains from most relevant to least in relation to a solar cooking themed lesson.



Dimension 2

CROSSCUTTING CONCEPTS

Connections across the four domains

SEVEN CONCEPTS

Patterns

Cause and effect

Scale, proportion, and quantity

Systems and system models

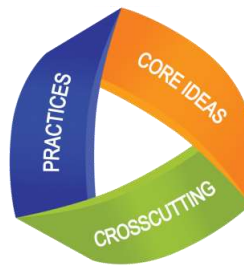
Energy and matter

Structure and function

Stability and change

nextgenscience.org

How can the crosscutting concepts be explored through a solar cooking themed lesson?



Dimension 3

PRACTICES

Investigate the natural world. Design and build systems.

SCIENCE AND ENGINEERING PRACTICES

Ask questions and define problems

Develop and use models

Plan and carry out investigations

Analyze and interpret data

Use math and computational thinking

Construct explanations and design solutions

Base arguments from evidence

Communicate information

nextgenscience.org

How can a solar cooking themed lesson reinforce every science and engineering practice?

Disciplinary Core Ideas

Crosscutting Concepts

Practices

Disciplinary Core Ideas

Physical Science

PS 1: Matter & its interactions

PS 2: Motion & stability: Forces & interactions

PS 3: Energy

PS 4: Waves & their applications in technologies for information transfer

Life Sciences

LS 1: From molecules to organisms: structures & processes

LS 2: Ecosystems: interactions, energy, and matter

LS 3: Heredity: information & variation of traits

LS 4: Biological systems: interaction: Unity & diversity

Earth & Space Sciences

ESS 1: Earth and the universe

ESS 2: Earth's systems

ESS 3: Earth and human activity

Engineering, Technology, & the Application of Science

ETS 1: Engineering design

ETS 2: Links among engineering, technology, science, & society

4-PS3-2 Energy

Students who demonstrate understanding can:

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

The performance expectation above was developed using the following elements from the NRC document A Framework for K-12 Science Education

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	PS3.A: Definitions of Energy • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. PS3.B: Conservation of Energy and Energy Transfer • Energy is present whenever there are moving objects, heated light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air, so as a result, the air gets heated and sound is produced. • Light also transfers energy from place to place. • Energy can also be transferred from place to place by electric currents, which can then be used safely to produce motion, sound, heat, or light. The currents may have been produced to begin with by transferring the energy of motion into electrical energy.	Energy and Matter • Energy can be transferred in various ways and between objects.
Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS3.A, MS-PS3.B, MS-PS4.B Common Core State Standards Connections: ELA/Literacy — ELA.4.7 ELA.4.8	Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS3.A, MS-PS3.B, MS-PS4.B Common Core State Standards Connections: ELA/Literacy — WHST.8-12.7	Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS3.A, MS-PS3.B, MS-PS4.B Common Core State Standards Connections: ELA/Literacy — WHST.8-12.7

1-PS4-3 Waves and Their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

1-PS4-3. Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light. [Clarification Statement: Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).] [Assessment Boundary: Assessment does not include the speed of light.]

The performance expectation above was developed using the following elements from the NRC document A Framework for K-12 Science Education

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on K-2 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions. • Plan and conduct investigations collaboratively to produce evidence to answer a question.	PS4.B: Electromagnetic Radiation • Some materials allow light to pass through them; others allow only some light through; and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. [Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.]	Cause and Effect • Simple tests can be designed to gather evidence to support or refute student ideas about causes.
Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: 2-PS1.A Common Core State Standards Connections: ELA/Literacy — W.1.7 W.1.8 SL.1.1	Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS3.A, MS-PS3.B, MS-PS4.B Common Core State Standards Connections: ELA/Literacy — WHST.8-12.7	Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS3.A, MS-PS3.B, MS-PS4.B Common Core State Standards Connections: ELA/Literacy — WHST.8-12.7

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MS-PS3-4 Energy

Students who demonstrate understanding can:

MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. [Clarification Statement: Examples of experiments could include comparing that water temperatures after different masses of ice, melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass, as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

The performance expectation above was developed using the following elements from the NRC document A Framework for K-12 Science Education

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on K-2 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions. • Plan an investigation individually and collaboratively, and in the design, identify independent and dependent variables and controls, what tools and materials are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.	PS3.A: Definitions of Energy • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the type, states, and amount of matter present. PS3.B: Conservation of Energy and Energy Transfer • The amount of energy is neither created nor destroyed. The temperature of a matter sample for a given amount depends on the nature of the matter, the size of the sample, and the environment.	Scale, Proportion, and Quantity • Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.
Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS1.A, MS-PS2.A, MS-PS2.C, MS-PS3.D, MS-PS4.B Common Core State Standards Connections: ELA/Literacy — WHST.8-12.7	Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS3.A, MS-PS3.B, MS-PS4.B Common Core State Standards Connections: ELA/Literacy — WHST.8-12.7	Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS3.A, MS-PS3.B, MS-PS4.B Common Core State Standards Connections: ELA/Literacy — WHST.8-12.7

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HS-PS3-3 Energy

Students who demonstrate understanding can:

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]

The performance expectation above was developed using the following elements from the NRC document A Framework for K-12 Science Education

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to evaluations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	PS2.A: Definitions of Energy • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. PS3.D: Energy in Chemical Processes • Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. ETS1.A: Defining and Delimiting an Engineering Problem • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary)	Energy and Matter • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering and Technology on Society and the Natural World • Modern civilization depends on major technological systems. Engineers contribute to modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.
Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS3.A, MS-PS3.B, MS-PS3.D Common Core State Standards Connections: ELA/Literacy — WHST.8-12.7	Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS3.A, MS-PS3.B, MS-PS3.D Common Core State Standards Connections: ELA/Literacy — WHST.8-12.7	Connections to other DCIs in this grade-band: Articulation of DCIs across grade-bands: MS-PS3.A, MS-PS3.B, MS-PS3.D Common Core State Standards Connections: ELA/Literacy — WHST.8-12.7

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Disciplinary Core Ideas

Crosscutting Concepts

Practices

Disciplinary Core Ideas

Physical Science

- PS 1: Matter & its interactions
- PS 2: Motion & stability: Forces & interactions
- PS 3: Energy
- PS 4: Waves & their applications in technologies for information transfer

Life Sciences

- LS 1: From molecules to organisms: structures & processes
- LS 2: Ecosystems: Interactions, energy, & dynamics
- LS 3: Heredity: Inheritance & variation of traits
- LS 4: Biological evaluation: Unity & diversity

Earth & Space Sciences

- ESS 1: Earth's systems in the universe
- ESS 2: Earth's systems and the environment
- ESS 3: Earth and human activity

Engineering, Technology, & the Application of Science

- ETS 1: Engaging in engineering design
- ETS 2: Linking engineering, technology, and society

MS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can

- MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

The performance expectation above was developed using the following elements from the HRC document A Framework for K-12 Science Education.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to provide evidence for phenomena.	LS2.A: Interdependent Relationships in Ecosystems • Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources; access to which consequently constrains their growth and reproduction. • Growth of organisms and population increases are limited by access to resources.	Cause and Effect • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Connections to other DCIs in this grade-band:

MS-ESS3.A, MS-ESS3.C
Articulation of DCIs across grade-bands:
3-LS2.C, 3-LS4.D, 6-LS2.A, MS-LS2.A, MS-LS4.C, MS-LS4.D, MS-ESS3.A

Common Core State Standards Connections:

- ELA/Literacy -
RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-1)
RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS2-1)

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

HS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can

- HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]

The performance expectation above was developed using the following elements from the HRC document A Framework for K-12 Science Education.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Single computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena or design solutions to support and revise explanations. Connections to Nature of Science Scientific Knowledge is Open to Revision in Light of New Evidence • Most scientific knowledge is quite durable, but it is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.	LS2.A: Interdependent Relationships in Ecosystems • Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms must have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance number of individuals of species in any given ecosystem. LS2.C: Ecosystem Dynamics, Functioning, and Resilience • A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its state or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and limited availability.	Scale, Proportion, and Quantity • Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.

Connections to other DCIs in this grade-band:

HS-ESS2-6, HS-ESS3.A, HS-ESS3.C, HS-ESS3.D

Articulation of DCIs across grade-bands:

MS-LS2.A, MS-LS2.C, MS-ESS3.C

Common Core State Standards Connections:

ELA/Literacy -

RST.11-12.1

Cite specific textual evidence to support analysis of science and technical texts, attending to distinctions the author makes and to any gaps or inconsistencies in the account. (MS-LS2-2)

Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (MS-LS2-2)

Mathematics -

MP.2

Model

MS.4

MS.GA.1

Reason statistically and quantitatively. (MS-LS2-2)

Model with mathematics. (MS-LS2-2)

Use units as a way to understand problems and to guide the solution of multi-step problems; convert units coherently in formulas, choose and interpret the scale and the origin in graphs and displays. (MS-LS2-2)

HS.N.GA.2

HS.N.GA.3

Choose appropriate quantities for the purpose of descriptive modeling. (MS-LS2-2)
Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

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HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can

- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

The performance expectation above was developed using the following elements from the HRC document A Framework for K-12 Science Education.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	LS2.C: Ecosystem Dynamics, Functioning, and Resilience • Understand anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. LS4.D: Biodiversity and Humans • Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary) • Humans depend on the living world for the resources and other benefits provided by biodiversity, but human activity is also having adverse impacts on biodiversity through introduction, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity as that ecosystem functions and productivity are maintained is essential to sustaining and enhancing life on Earth. Sustaining biodiversity also puts humanity in a position to harness the power of biodiversity for economic, social, and cultural value. (secondary) Now, This disciplinary core idea is also addressed by HS-LS4-8. ETS1.C: Developing Possible Solutions • When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability, and aesthetics and to consider social, cultural, and environmental impacts. (secondary)	Stability and Change • Much of science deals with constructing explanations of how things change and how they remain stable.

Connections to other DCIs in this grade-band:

Disciplinary Core Ideas

Crosscutting Concepts

Practices

Disciplinary Core Ideas

Physical Science

PS 1: Matter & its interactions

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LS 2: Ecosystems: interactions, energy, & dynamics

LS 3: Heredity: inheritance & variation of traits

LS 4: Biological evolution: Unity & diversity

Earth & Space Sciences

ESS 1: Earth's place in the universe

ESS 2: Earth's systems

ESS 3: Earth & human activity

Engineering, Technology, & the Application of Science

ETS 1: Engineering design

ETS 2: Links among engineering, technology, science, & society

1-ESS1-1 Earth's Place in the Universe

Students who demonstrate understanding can:

1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted. [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.]

The performance expectation above was developed using the following elements from the NRC document A Framework for K-12 Science Education.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Use observations (gathered or from media) to describe patterns in the natural world in order to answer scientific questions.	ESS1.A: The Universe and Its Stars • Patterns in the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. • Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems. • Science describes natural events (natural history) as they happened in the past. • Many events are repeatable.	Patterns • Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. • Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems. • Science describes natural events (natural history) as they happened in the past. • Many events are repeatable.

Connections to other DCIs in this grade-band:
 Articulation of DCIs across grade-bands:
 MS-ESS1.B, MS-ESS1.C, MS-ESS1.D
 Common Core State Standards Connections:
 ELA/Literacy:
 W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how to" books on a given topic and use them to write a sequence of instructions). (1-ESS1-1)

Mathematics:
 MP.2 Reason abstractly and quantitatively. (1-ESS1-1)
 MP.4 Model with mathematics. (1-ESS1-1)

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Science Education

Disciplinary Core Ideas

Crosscutting Concepts

Science and Engineering Practices

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

5-ESS3-1 Earth and Human Activity

Students who demonstrate understanding can:

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

The performance expectation above was developed using the following elements from the NRC document A Framework for K-12 Science Education.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Observing, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 3-5 builds on K-2 experiences and progresses to evaluating the merit and accuracy of ideas and evidence. • Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.	ESS3.C: Human Impacts on Earth Systems • Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, oceans, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.	Systems and System Models • A system can be described in terms of its components and their interactions. • Connections to Nature of Science Science Addresses Questions About the Natural and Material World. • Science findings are tested to determine that they can be supported with empirical evidence.

Connections to other DCIs in this grade-band:
 Articulation of DCIs across grade-bands:
 MS-ESS3.A, MS-ESS3.C, MS-ESS3.D
 Common Core State Standards Connections:
 ELA/Literacy:
 RLS.1 Cite accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-ESS3-1)
 RLS.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS3-1)
 RLS.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-ESS3-1)
 W.5.8 Recall relevant information from experiences or other relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-ESS3-1)
 W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-ESS3-1)
 MP.3 Reason abstractly and quantitatively. (5-ESS3-1)
 MP.4 Model with mathematics. (5-ESS3-1)

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Science Education

Disciplinary Core Ideas

Crosscutting Concepts

Science and Engineering Practices

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

Engaging in Argument from Evidence

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Engaging in Argument from Evidence

HS-ESS3-4 Earth and Human Activity

Students who demonstrate understanding can:

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or oceans).]

The performance expectation above was developed using the following elements from the NRC document A Framework for K-12 Science Education.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Design or refine a solution to a complex real-world problem, based on scientific knowledge, principles, and theories; and assess whether the design meets the criteria and constraints for the problem.	ESS3.C: Human Impacts on Earth Systems • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. ETS1.B: Developing Possible Solutions • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability and aesthetics, and to consider social, cultural, and environmental impacts (secondary).	Stability and Change • Feedback (negative is positive) can stabilize or destabilize a system. • Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Connections to other DCIs in this grade-band:
 HS-ESS2.C, HS-ESS2.D
 Articulation of DCIs across grade-bands:
 MS-ESS2.A, MS-ESS2.B, MS-ESS2.C, MS-ESS2.D
 Common Core State Standards Connections:
 ELA/Literacy:
 RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS3-4)
 RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data where possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-4)
 Mathematics:
 MP.2 Reason abstractly and quantitatively. (HS-ESS3-4)
 HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS3-4)
 HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS3-4)
 HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS3-4)

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Science Education

Disciplinary Core Ideas

Crosscutting Concepts

Science and Engineering Practices

Engaging in Argument from Evidence

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nextgenscience.org

Solar oven themed lessons in practice

INTRODUCE SOLAR COOKING AS AN ENGINEERING DESIGN CHALLENGE

Identify Problem or Need

Researchers at the Polar Environment Atmospheric Research Laboratory in the Arctic Circle on Ellesmere Island, Canada want to conserve and reduce cooking fuel. It is difficult to transport this fuel to the Research Lab. Researchers also want to reduce the pollutants they are releasing into the air in this environment.

Design Brief

Statement

With your team, design a solar oven model for use at the Polar Environment Atmospheric Research Laboratory. Label how the oven is designed to direct sunlight, absorb sunlight and convert to heat, and retain heat. Remember DARE (Direct, Absorb, Retain, Eat)

Specifications

The oven must utilize reflectivity to gain as much sunlight as possible at low angle.

The oven must include an insulated cooking space so it does not lose thermal energy to the outside.

The oven must cook at temperatures that are safe for food.

The oven must be made of materials that are durable and sturdy.

The oven must withstand windy days and occasional wind gusts.

Technology Should Serve Humanity, Not the Other Way Around.

Tim Cook

Identify Problem or Need

Natural disasters can knock out power to a home and community for days and even weeks. Without power, food cannot be refrigerated or cooked using a conventional indoor stove. People may need to rely on dried goods such as rice, beans, and root vegetables.

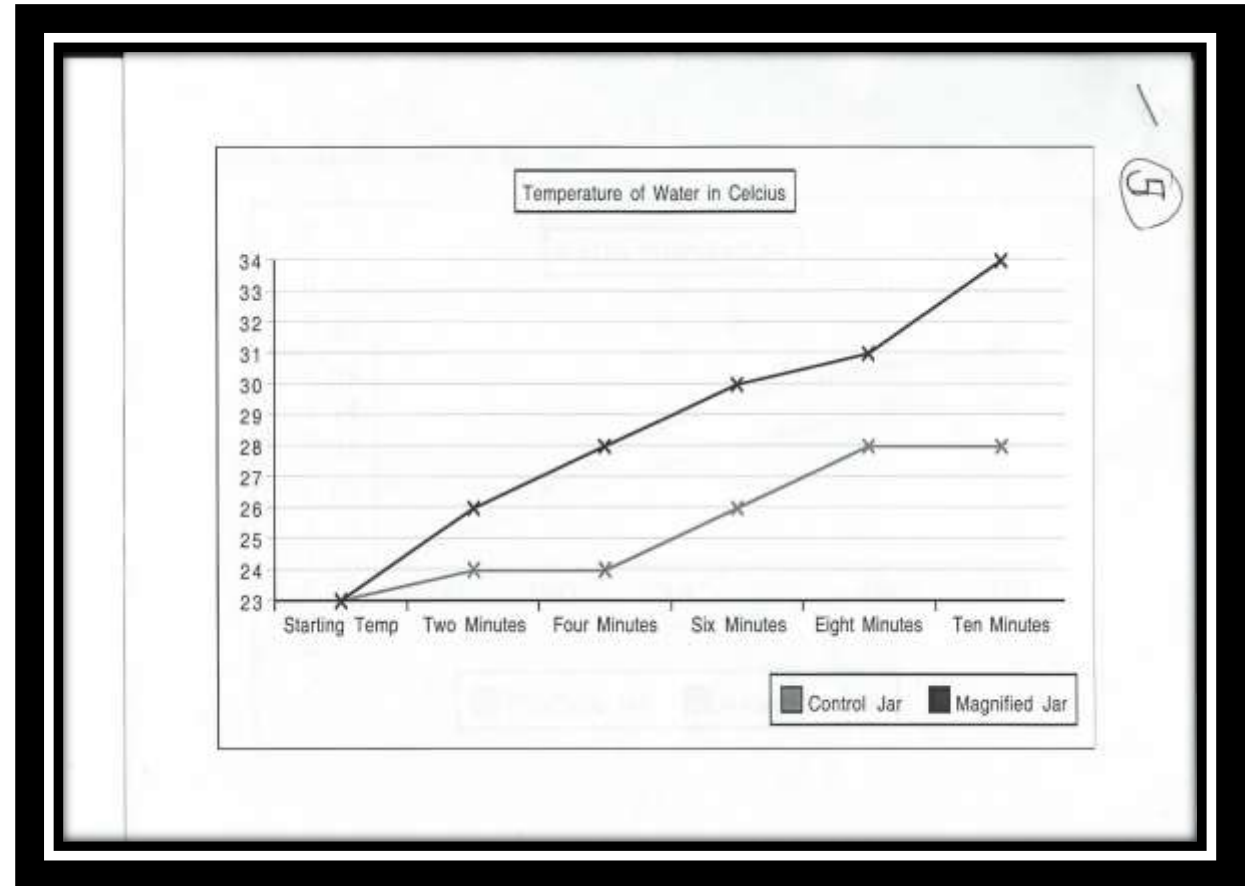
Identify Problem or Need

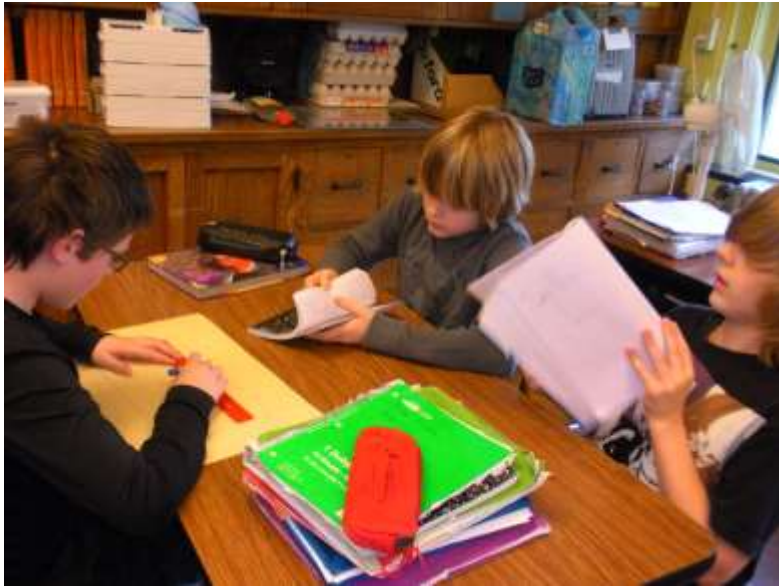
A church in Haiti cooks daily for about 50 school children. The church would like to learn to use solar ovens to reduce the money spent on charcoal for cooking. With the money they save, they will buy nutritious food for the children.



Students conduct experiments and participate in class activities that reinforce Disciplinary Core Ideas.

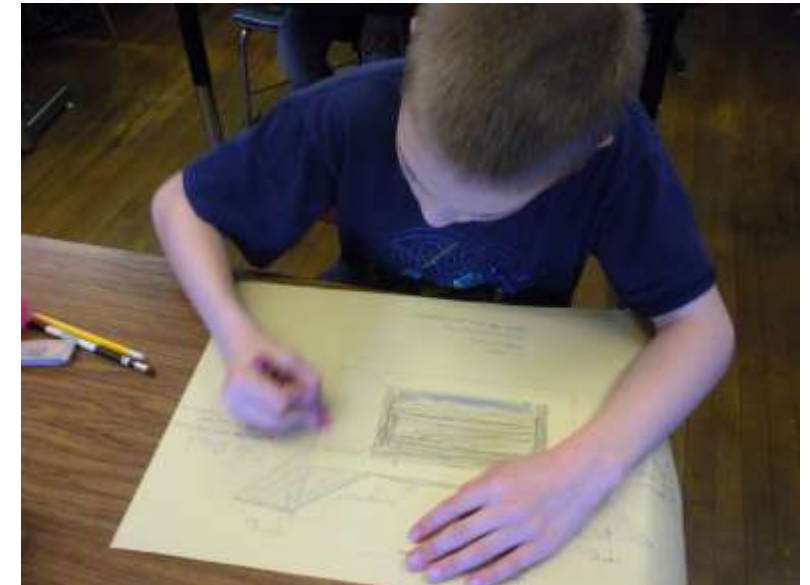
What effect will focusing light on a penny inside a jar of water have on the temperature of the water?
(This experiment and more can be found at GDSnonprofit.org/education)





RESEARCH DESIGN COLLABORATE

**Students use Disciplinary
Core Ideas as the basis
for Engineering Design.**



SCIENCE AND ENGINEERING PRACTICES

Build a prototype that is your
team's solution to the
problem.





TEST AND EVALUATE

Students conduct
temperature and time
tests to evaluate ovens.
Discuss changes that can
be made.



COMMUNICATE SOLUTIONS

Students discuss solar oven construction with each other, other classes, and adults. Write ideas in science journals.



Representative from the office
of Congressman Tim Ryan.



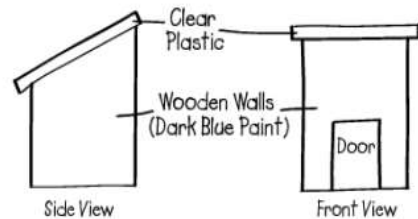
ASSESS IN WAYS CONSISTENT WITH STANDARDIZED TESTING

32.)

A teacher asks his students to design a dog house choosing from the following materials:

- White paint
- Dark blue paint
- Black paint
- Large sheets of aluminum metal
- Wooden boards
- Clear plastic

A student makes a sketch of the dog house.



The student's teacher tells her that the dog house she designed is not safe for a dog. The temperature inside the dog house would become too warm in the summer.

Identify one change she could make to the design of the dog house to keep the inside cooler.

Then, explain how that change would make the dog house cooler in the summertime.

Type your answer in the space provided.

33)

Standard, Physical Science 2

In tropical locations, the roofs of homes are often painted white to prevent the temperatures inside the home from getting too hot.

Which statement explains how white roofs keep the temperatures lower inside homes?

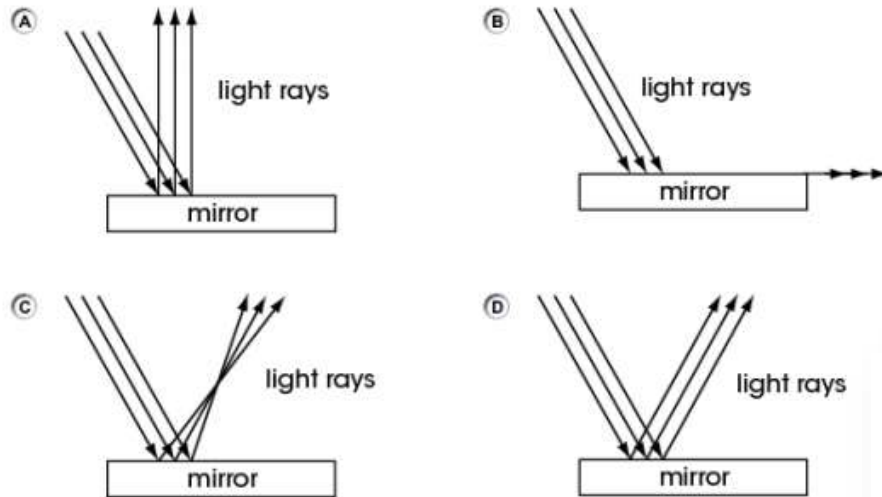
- Ⓐ The white paint reflects the sunlight.
- Ⓑ Sunlight refracts through the white paint.
- Ⓒ Sunlight is absorbed and trapped in the white paint.
- Ⓓ The white paint allows sunlight to travel through the roof.

These sample questions from a state standardized test demonstrate how a solar cooking themed lesson can prepare students to understand related concepts.

38)

Standard, Physical Science 2

Which diagram correctly shows the reflection of light from a smooth, flat mirror?



These sample questions from a state standardized test demonstrate how a solar cooking themed lesson can prepare students to understand related concepts.

53)

Standard, Earth and Space Science 3

The figures show the sun's rays shining on Earth's surface in Ohio. Figures 1, 2 and 3 show the same time of day, but on different dates.

Move a date label into each blank box to show the possible dates for the three figures.

- Move only **one** label into each blank box.
- There may be more than one correct answer.
- You do **not** need to use all the labels.

Figure 1	Figure 2	Figure 3
Date <div></div>	Date <div></div>	Date <div></div>
Ohio South North	Ohio South North	Ohio South North
January 1	April 1	July 1
		October 1

**The need for teaching skills
in a relevant context
is universal.**

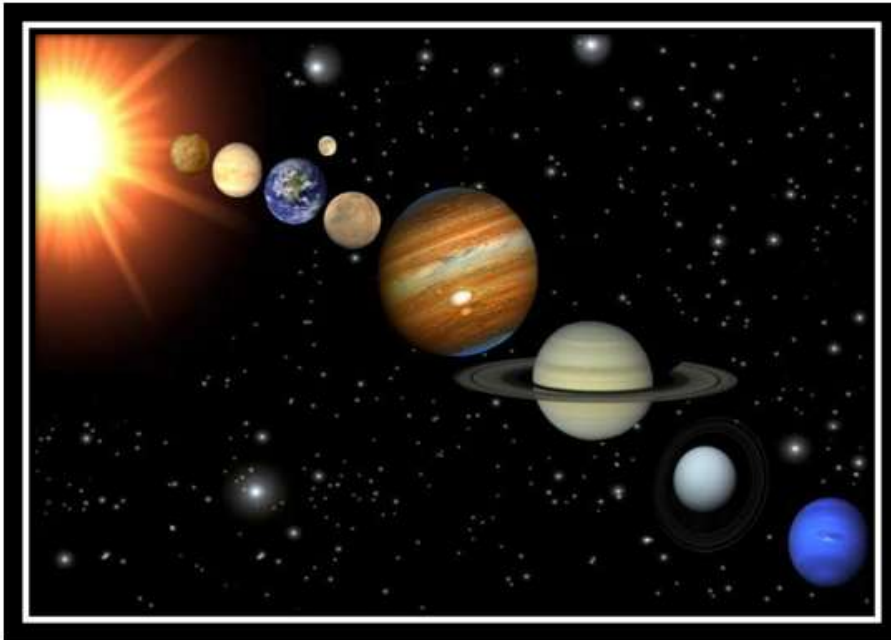
**Examples of solar cookers as
tools for STEM education
here and abroad.**

Solèy la Etonan

Amazing Sun

Solèy la se yon etwal. Li se nan sant la nan sistèm solè nou an. Planèt yo, ki gen ladan Latè, gravity alantou solèy la.

The sun is a star. It is the center of our solar system. Planets, including Earth, revolve around the sun.



Latè planèt nou an se planèt la twazyèm soti nan solèy la.

Nou se 150 milyon kilomèt soti nan solèy la.

Our planet earth is the third planet from the sun. We are 150 million kilometers away from the sun.



Teaching about solar cooking concepts in Haiti at Institucion Mere Delia with WeCaretoShare.





Camilly and Gaudenzia Wedende of Eldoret, Kenya, teach children and adults the basic concepts of solar cooking and its many uses with support from Student Solar Cooking Science Projects and GDSnonprofit.

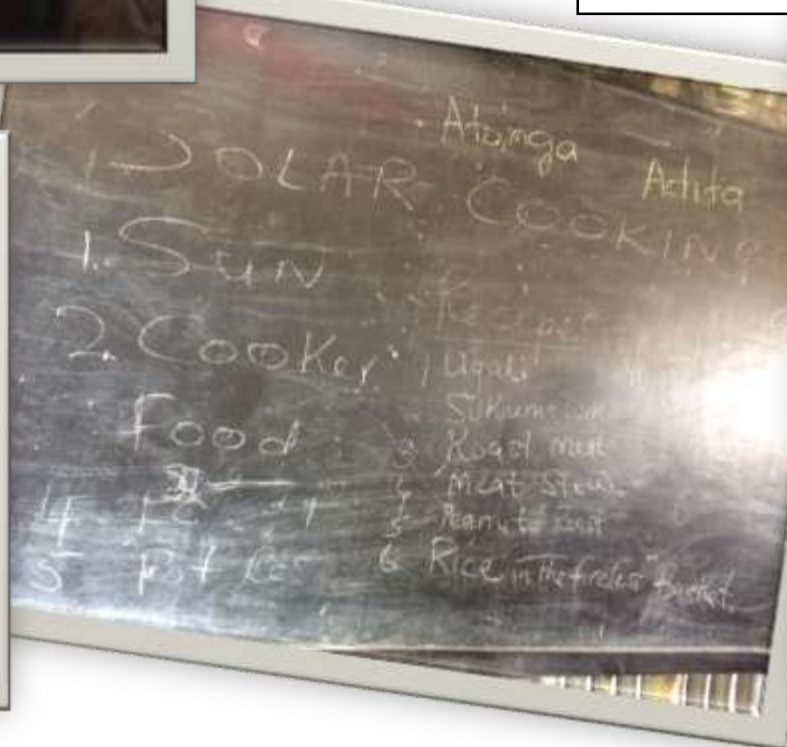




Students at Korando Educational Center in Kisumu, Kenya learn about integrated cooking, including solar, from instructors Faustine Odaba and John Amayo through a GDS sponsored three day workshop.



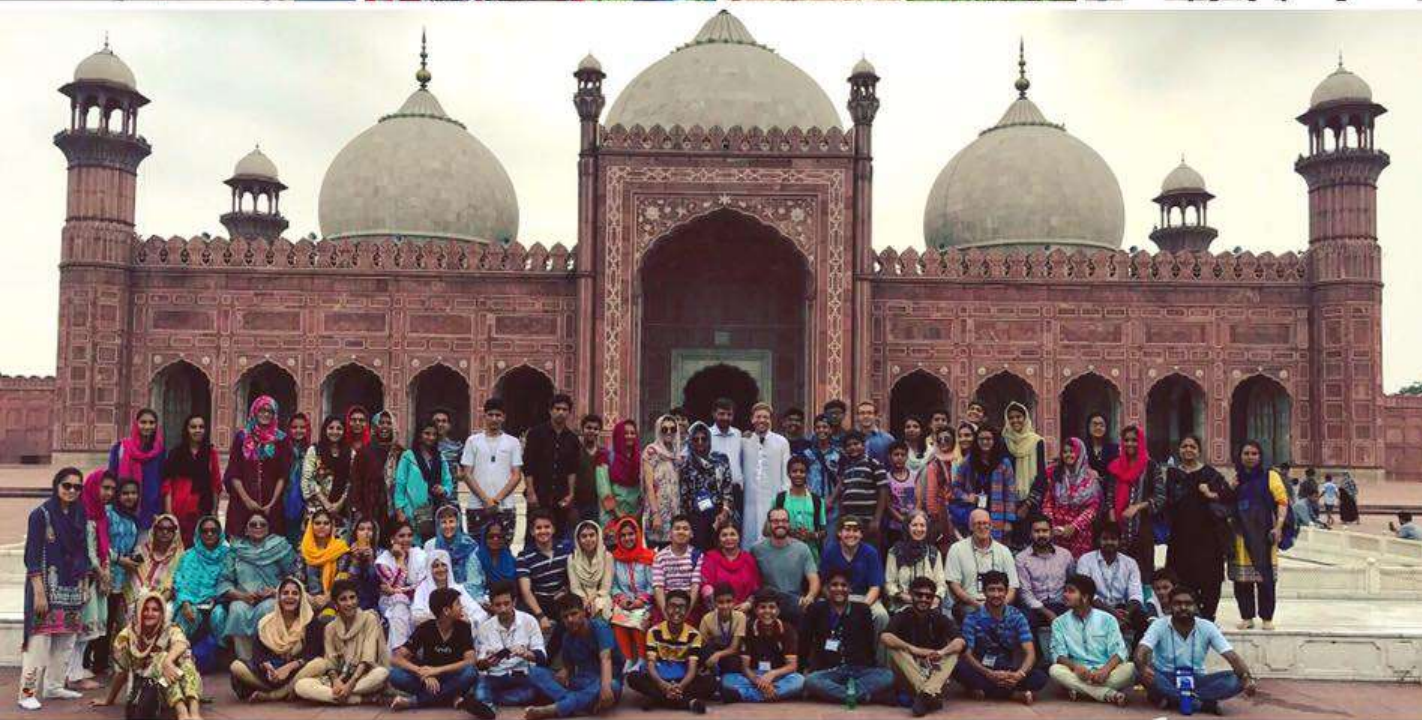
Students gather round their new SolSource, donated by Hubbard, Ohio Rotary Club, at Korando Educational Center in Kisumu, Kenya. Training program sponsored by GDS.



**The Solar Sisters, GDSnonprofit conduct workshops on solar cooking for students at Learning Streams International Institute at Hiram College.
Students from USA, Pakistan and Dominican Republic attend.**



Teachers and students in Pakistan learn about solar cookers as part of Learning Streams International's ecology education program. Workshop conducted by John Buchenic of GDSnonprofit.





Bethel Business and Community Development Centre
is a commercial and technical school located in a remote rural district of Lesotho.
Mission

To design and manage innovative learning environments for young people in Lesotho that elicit general engineering skills, business savvy, manual capabilities, applied sciences, systems thinking, leadership and management abilities that address the needs of career and business development in Lesotho.

Photo Credit Ivan Yaholnitsky



PART 2

Susan Schleith and Penny Hall



FLORIDA SOLAR ENERGY CENTER™

Creating Energy Independence





FLORIDA SOLAR ENERGY CENTER™

Creating Energy Independence



Mission: To research and develop energy technologies that enhance Florida's and the nation's economy and environment and to educate the public, students and practitioners on the results.

Professional Development for Teachers

Solar Cooker Workshops

- Curriculum – concepts, standards, resources and implementation
- Hands-on, team-driven, problem/project-based





Solar Energy Cook-off



Students share their projects

- EnergyWhiz & EnergyWhiz Expo Events
- Demonstration, showcase and competition for student team projects
- Awards in Design, Culinary, Fresh from Florida & WOW





Designed and Built by Students



Box Cookers





Designed and Built by Students

Panel Cookers





Designed and Built by Students



Parabolic Cookers





Designed and Built by Students



Solar Hybrid & Lens Cookers





Students Solar Cooking





Students Solar Cooking





Solar Culinary Arts

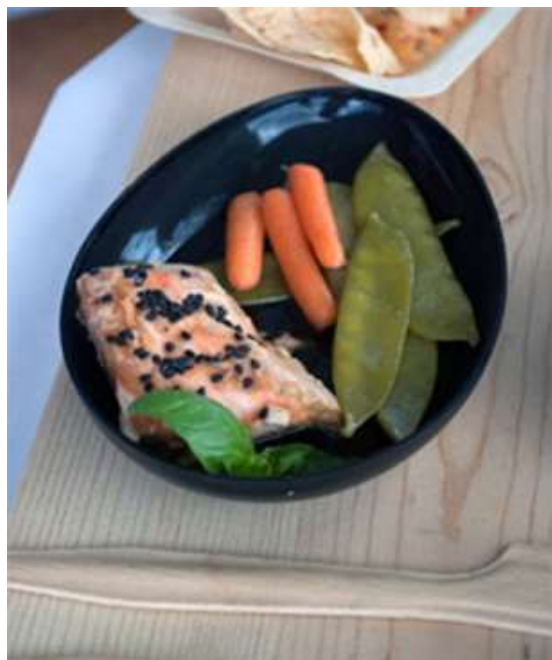


Delicious Creations!





Solar Culinary Arts



Fresh From Florida!



Solar Culinary Arts



More than S'mores!



WOW!





Contact Information



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Session powerpoint, cooker plans, curriculum (K-12),
cooking tips, recipes & more

<http://www.fsec.ucf.edu/download/Education>